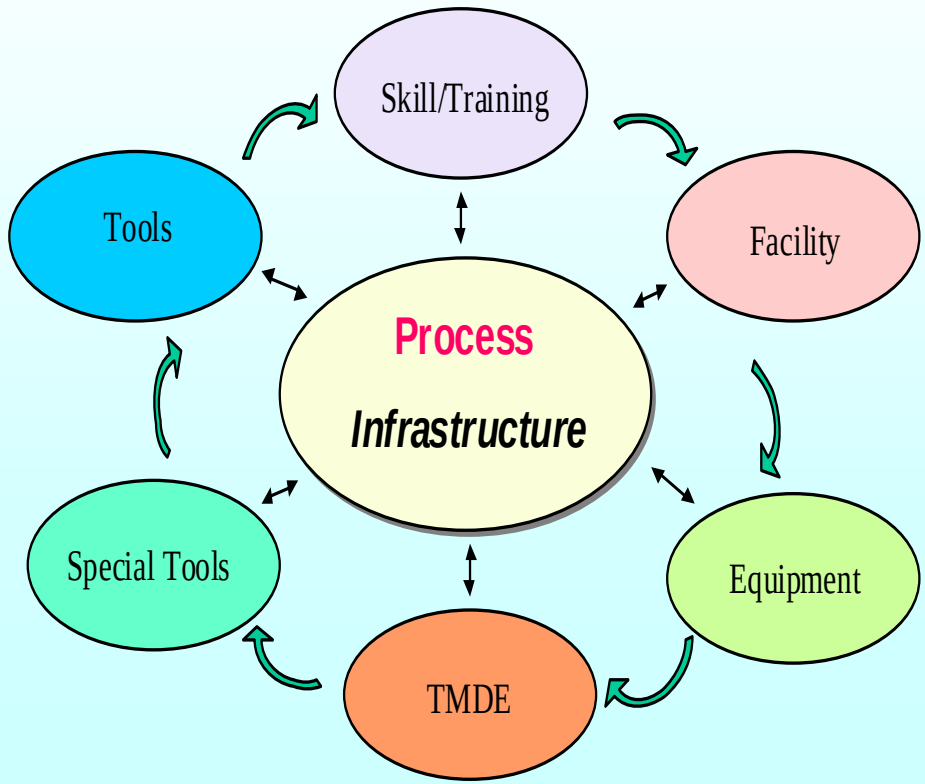
HMMWV ENGINE OVERHAUL PROCESS IMPROVEMENT

IMPROVEMENT OBJECTIVES

- **Design a robust and adequate repair process to warrant a consistent level of Quality and production at a reasonable price**
- **Increase work force productivity**
- **Insure standard and efficient methods of work control**
- **Provide appropriate response to customer requirements**
- **Attain the maximum practical usage of resources in the field of Infrastructure (see chart)**



ENGINE OVERHAUL BEFORE IMPROVEMENT PROJECT (OCT 2001)

Topic 1

- **Production at 5 different locations including**

  engine repairs at *3 locations*

  Bldg # 2236: wash rack

  Bldg # 2225: painting

  Bldg # 2222: engine repair

  Bldg # 2233: HEMCO engine repair

  Bldg # 2233: Engine Repair Section

  engine and container repair, testing, preservation and shop stock.

Problems/Problem Areas:

- **Multiple transportation over long distances (985 ft) !**
- **High risk potential for accidents !**
- **Difficult to control the process !**
- **Duplication of functions !**
- **Multiple disturbances, e.g. missing parts, tools, resources, etc.**

ENGINE OVERHAUL BEFORE IMPROVEMENT PROJECT (OCT 2001)

2226

Breakroom

Parts Washer

2225

770 feet
6 min *2

Vehicle Preservation

HMMWV Engine & Container Paint Shop

Welding

Paint

2220

2222

Shop stock

Office

Break& Locker

Interim HMMWV Engine Repair Shop

Final Drive Teststands 3ea

X-Mis Teststands 2ea

520 ft
4 min *2

HIRSCHBIEL AVENUE

OFFICES ROOM #106

2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54

FRAME ALIGNMENT

540 ft / 4 min *2

DRIVEWAY

520 ft
4 min *2

UNSERV ASSETS EMC

1 3 3A 5 7 9 11

33 35 37 39 41 43 45 47 49 51 53 55 57 59

METAL TREATMENT MACHINES

LKWAY

TOOL ROOM

PW

HMMWV Engine Disassembly & Assembly

CONF ROOM

OoC

STATISTIC

DS OFFICE

WASH ROOM 2

OFFICE

HMMWV Engine Preservation

PUMP REPAIR

ENGINE

SHOP

HMMWV Engine Disassembly & Assembly

WASH ROOM 1

WELDING SHOP

OFFICE

BREAK ROOM

PW

GENER

TEST

DLR MI PP

REEFER TEST

STORAGE ROOM

3 EA ENGINE TEST CELLS

HMMWV Engine Test Cells

Bldg# 2236
Wash Rack

2233

Processing areas

Parts Washer

Transport way

Only one overhead crane available at processing area

Break area inside Maintenance Shop

ENGINE OVERHAUL IMPROVEMENT PROJECT

Improvement 1

Production at 4 different locations concentrate engine repair at *1 location*

Bldg # 2236: washing place

Bldg # 2225: painting, container repair, preservation

Bldg # 2233: Engine Repair Section III: engine repairs and testing, shop stock

Bldg # 2233: Former Battery storage: new fuel injection pump test room

- Less Disturbances and lower accident risks due to less transportation and shorter distances!
- Reduction of storage and handling of hazardous material
- Reduction of welding fumes
- Elimination of duplicated efforts
- Better process control due to engine repair at one location
- Less faults on fuel injection pumps during test phase due to tests and adjustments before installing!
- Establish (auto) processes to warrant consistently high level of quality.

Results

- Cost savings due to better use of resources.
- Reduced processing time.
- Quality Improvement.
- Optimization of process and process control.

ENGINE OVERHAUL IMPROVEMENT PROJECT

Topic 2

- **Tools and equipment not up to date to today's technology requirements!**
- **Work place design not state of the art!**

Improvements

- **Optimized utilization of resources (Employees, Tools, Time)**
- **Overhead connected pneumatic powered tools**
- **Component finishing machines (Valve grinder, cylinder head finisher)**
- **Economic, environmentally safe storage and use of parts**
- **Washing machines (loading from two sides, faster washing process, minimized waste)**
- **Modernization of test cell (quick connectors, self adjusting)**
- **Optimized work lighting (300 - 500Lux)**

Results

- **Reduced handling & transportation**
- **Controlled structured process**
- **Enhanced safety**

ENGINE OVERHAUL IMPROVEMENT PROJECT

Topic 3

- Current Repair Process is based on single part production
- Extended rework on repaired engines identified during Final Test
- Most common failures
  - 50% defective fuel injection pumps
  - 30% abnormal oil pressure
  - 10% engine block cracks
  - 10% general leaks

Results

- Optimization of processes
- Improved process control due to detailed description of work processes
- Enhanced process planning supported by detailed process definition and floor lay outs.
- Quality improvement and production increase due to change of production practices.
- Quality cost control and management based on real-time process capability monitoring

Improvements

- Reengineering of work flow and process
- Furnish install/redesign, the following work stations/machines including special tools, equipment, technical procedures, work descriptions IAW safety regulations and ISO 9001:2000

➢ cylinder head inspection, measurement and repair station
➢ crankshaft, camshaft and cylinder block diagnostic and build
➢ test and repair station for hydraulic pump
➢ fuel injection nozzle, glow plug and oil pump station
➢ fuel injection pump test room
➢ designated area for container storage, repair and engine preservation, disassembly station
➢ two new washing machines
➢ Hairline crack/identification station (Flux, UV-dye test, black light or equivalent)
➢ designed interim storage location for condition code “F”, “H”, at material and waste
➢ designed interim storage location for repaired engines waiting for testing
➢ Installation of an assembly line with adequate special tool equipment and IAW safety/technical procedures and ISO 9001:2000
➢ Work process integrated bore and honing machines (4 ea)
➢ Removal of three (3) M1 hydraulic test stand at an alternate place

ENGINE OVERHAUL IMPROVEMENT PROJECT

Topic 4

- Low level of Motivation drives a high sickness absence rate of employees

Results

- Higher motivation
- Boosting self esteem
- Lower sickness rate
- Group dynamic
- Production increase
- High level of Quality

Improvements

- Building of well defined work stations and responsibilities
- Higher motivation and boosting self esteem due to building of work groups, temporary group leaders and self-inspection instead of external inspection.
- Increased responsibility for group members to meet production goal.
- Rotation of group members between work groups/stations to promote job enrichment and technical education, and to build a pool of highly knowledgeable technical professionals and expertise.
- Increased individual responsibility and relationship between internal and external customers and suppliers
- Build the esprit-de-corps through increased self responsibility and identification with product

HMMWV ENGINE OVERHAUL NEW PRODUCTION LOCATION

New break room outside maintenance area

New pump test and Injection room

New engine test cell

Parts washer moved from former production area

8.00 m

8.35 m

3.00 m

19.00 m

Drainage

4 Pump Test and Injection Room

3 2 1

Breakroom / Container

DIN EN ISO 9001:2000

Future Sand blast machine

Engine painting

Preservation

Break room | Office

M 1 Turbine | 121 | Test-Cell 122

Office

9 Interim Storage/ Engines ready for testing

3 2 1 Honing and Boring machines

WM

5 Container Storage

11

Individual production

10 Assembly

Single - Production

Production line process

Info-Board's

Control and measuring

1 2

Testing

3

crane 5 ton

6

8

Engine and Container preservation

Storage for replacement parts

7

WM

12

WM

3.0 m

34,4 m

88.0 m

20,5 m

11,1 m

New overhead crane

New parts washers reduce traveling to wash rack Bldg# 2236

Legend

- rack for parts
- forklift
- freestanding shelf
- engine stand
- pallet
- underbrace jib cran
- movable shelves for dismantle parts
- Mobile shelf
- engine container
- waste

Bldg # 2225

5

Office

Paint

not to scale
prepared by GSC-E
QAMO, QET, Jan. 2005

Legend (by number)

1 cylinder head repair shop

2 Measurement station of crankshaft, camshaft and cylinder blocks

3 Test/Rep of hydraulic pump, fuel injection nozzle, glow plug and oil pressure pump

4 Test room of fuel injection pump

5 Container storage and engine container preservation station

6 Disassembly line

7 Washing machine

8 Interim storage for condition codes

9 Interim storage for repaired engines waiting for testing

10 Assembly line

11 Boring and honing machines

12 Install Dry cleaning container (Exhaust-System) located on south-side of room, near to the wash machines

13 Install additional new crane in Engine repair shop

PARTS & SUPPLY IMPROVEMENTS

Before	After
Administration of repair parts	
Maintenance determines the quantity of the program stock, stores and issues the parts to the mechanics	Supply takes over all parts related tasks; determination of program stock quantity, receipts, storage and issuance
Parts lists:	
No parts list available, used up parts were listed manually, mandatory replacement parts were not tracked. Each section had their own parts list formats	Preprinted, integrative part lists with marked mandatory parts and necessary quantities for all sections. Parts Requirement Lists (PRL) are accessible via the internal network. PRLs are centralized managed by Production Control and hardcopies are added to the WO package.
Control of Shop stock:	
As required by the program and discretion of the workshop, no inventory.	Based on part lists and the actual consumption in the last year (Mortality), definition of program quantity and monthly schedule
Receipt of parts from SSA:	
All parts for AWCS where shipped to one location for further distribution: sorted, booked in SAMS-1 and transported to the actual repair facility at MAK.	Segregation, including posting within SAMS 1, is centralized at MAK.
Receiving of parts:	
Warehouse worker removed DA1348 from each part and forwarded it to the SAMS-1 operator for manual posting and selection of a storage location. (Mandatory 36 line items per engine). DA 1348 returned to the warehouse worker, who took the part out of the multi-box and stored it in the annotated location.	Warehouse worker scans the DA1348 with an electronic mobile device. Storage location is automatically selected. SAMS-1 posting will take place after storage on-site.

Summary: With the delegation of supply functions to the appropriate personnel, mechanics concentrate on their core function. In all other aspects the operational sequences became more effective, more efficient and more transparent. In addition, the loss of production hours, due to missing parts was reduced by 90%.

PRODUCTION PROCESS CHANGES

Before	After
Repair flow	
Control of work performance difficult. No reliable data on progress.	Clear and easy monitoring of work process, less rework and automated pulling of work flow by the different stations
Repair Standard	
10/20	Higher extended Standard: NMWR (National Maintenance Work Requirements = Depot overhaul)
Uneconomical Repairs	
Not included - shown on separate work orders	Man hours of washouts are fully included in the average of repair hours (Washout rate up to 40%)
Painting, Preservation & Packaging (PP&P)	
Not included - shown on separate work orders	Man hours are fully included in the average of repair hours (est. 10%)
Quality	
98.6 % customer satisfaction rate	Remains above 98% despite much higher output rates (300% increase)

Summary: The exact amount of direct labor hours saved can not be determined due to changes in repair and calculating requirements during the redesign effort. However, tangible and intangible savings are still considerable as well.

The average repair hours could be kept and stabilized, despite a higher repair standard and including of:

a) Washouts (40%) in average 8 hours per engine and

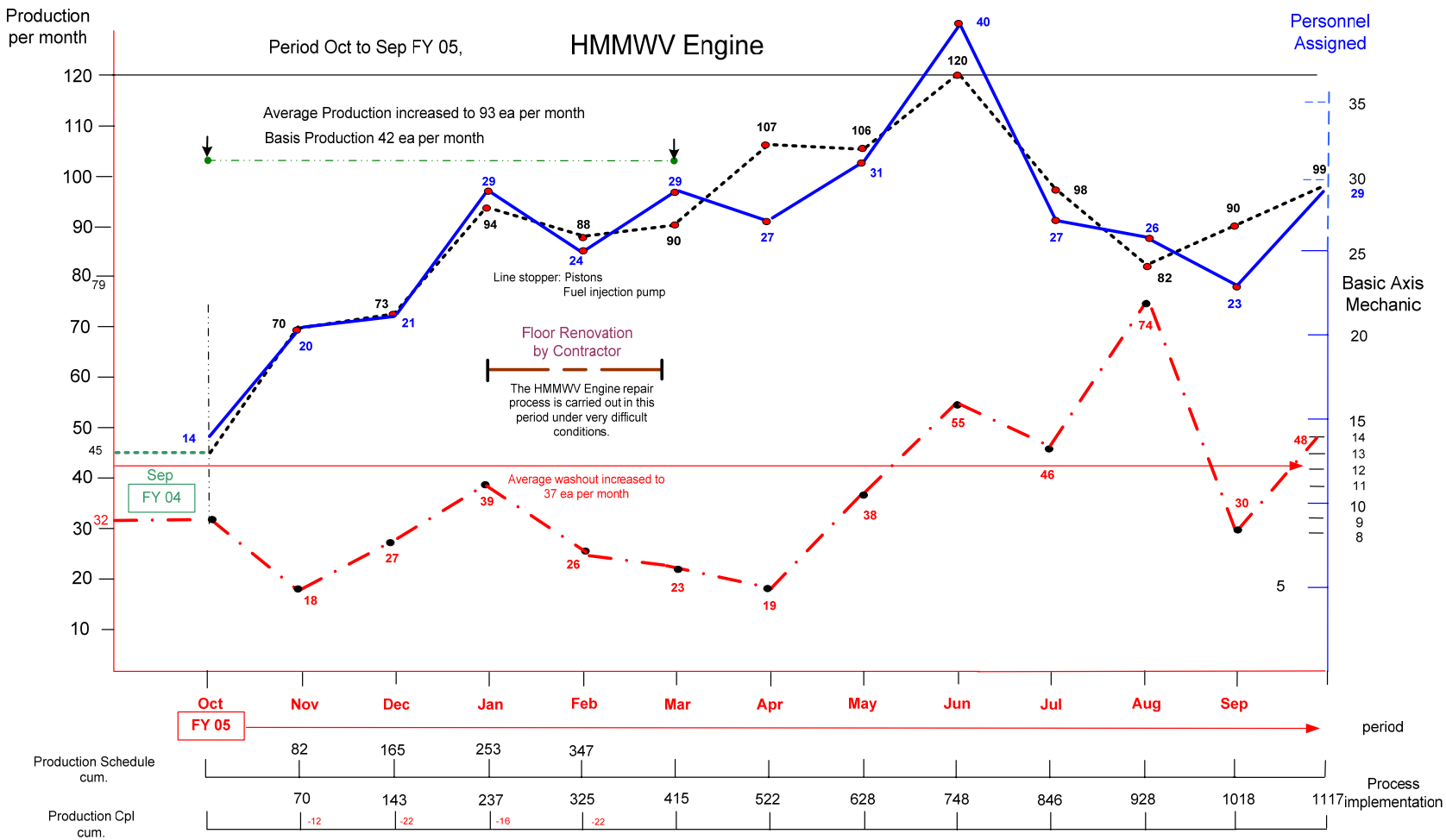
b) PP&P (10%) in average 5 hours per engine

ENGINE OVERHAUL PRODUCTION FY 05 SAVINGS

	MAK Plant Rate $	Time Minute	FY05 Production	Man Hour Savings $	Man Hour Savings #
LABOR HOURS SAVINGS					
Transport saving reduction from 4 production locations to 1 production location	37.89	24	1560 *	$23,643.36	624.00
Parts lists (See Encl 1)	37.89	30	1117	$21,161.57	558.50
Control of Shop Stock	37.89	10	1117	$7,053.86	186.17
Receipt of parts from SSA	37.89	30	1117	$21,161.57	558.50
Receiving of parts	37.89	72	1117	$50,787.76	1,340.40
Managing of PROST's (decrease from 225 to 25 yearly)	37.89	10	200	$1,263.00	33.33
Reduce of engine test time (1 inspetor / 2 test cells at one time)	37.89	60	1117	$42,323.13	1,117.00
Induction of preservation hours	37.89	300	1117	$211,615.65	5,585.00
Induction of uneconomical repairs (washouts) - est. 40% of 1117	37.89	480	443	$134,282.16	3,544.00
RESOURCES					
Transport saving reduce 4 production locations to 1 production location					
Forklift STIHL 4000 lbs Hourly Rate $ 7.11	7.11		1560	$4,436.64	
TOTAL SAVINGS FY 05				**$517,728.68**	
TOTAL MHRS SAVINGS					**13,546.90**
TOTAL MAN YEARS SAVINGS (based on 1520 mhr/yr)					**9**

* includes 443 engine washouts

ENGINE OVERHAUL PRODUCTION FY 05



Legend

- Production (ea)
- Washout
- Mechanic

NSN	Nomenclature	End Item	Prog Qty
2815012313672	ENGINE,WITH CONTAIN	HMMWV, HI MOB MULTI-PUR	283
2815013147940	ENGINE,WITH CONTAIN	HMMWV, HI MOB MULTI-PUR	545
2815014396664	ENGINE,WITH CONTAIN	HMMWV, HI MOB MULTI-PUR	185
2815014398164	ENGINE WITH CONTAIN	HMMWV, HI MOB MULTI-PUR	120
2815014617078	ENGINE W/C HMMWV,	HI MOB MULTI-PUR	84
		Total 1217	

Status :

30.09.2005

compl. 1117 ea